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GAS-BEARING ZONES AND CENTERS OF USSR COAL DEPOSITS

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Barzasskiy Rayon of the Kuzbass

Barzasskiy coal is in an early stage of carbonification (long flame) even in comparison with younger Upper Paleozoic coals found in the Kuzbass depression. This is explained by the variation in the original native coal substance, and the platform (priplatformennyy) character of the stratification of Devonian coals.

The origin of gas is closely connected with the formation of this type of coal. Many borings made in the Barzasskiy Rayon reaching the coal-bearing layer encountered gas which was given off in the form of a fountain.

Results of analyses of the gas from these bore holes are shown in the following table according to data of Geliogazrazvedka (Helium Gas-Prospecting Trust).

Percentage Composition of Gas

Test No	CH_4	C_2H_2	CO_2	O_2	Inert Gases	Inert Gases: Heavy	Inert Gases: Light
92	65.8-69.7	Traces-0.2	0.2	None	29.9-34.0	0.47-0.497	0.056-0.067
85	15.9	0.1	1.3	0.1	82.6	0.894	0.020
110	2.8	Not determined	0.10	None	9.3	0.163	0.001
1-D	44.2	Traces	0.8	0.4	54.6	0.694	0.047

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NOTE: In tests 92 and 85, the bore holes smelled of hydrogen sulfide.

In test 110 the remaining 87.2 percent was hydrogen.

This table gives evidence that the gases consist mainly of methane and are characteristic of coal deposits. Other gases are encountered, sometimes in large quantities, for example, the 82.7 percent hydrogen. Heavy hydrocarbons, mainly ethane C_2H_6, and inert gases both heavy and light were also present.

Ural Region (Yegorshino Deposit)

At the end of 1944, sudden ejections of coal and gas occurred in Yegorshino for the first time in the history of the Ural coal mines. This was observed particularly frequently in development workings in seam 10-m at the 200-meter level in Mine No 2 of the Yegorshinugol' Trust. These phenomena were repeated more and more frequently and in several instances 80 tons of coal were ejected.

It must be assumed that the intensity of these ejections increases even more at deeper levels, especially since the complex geological conditions of the entire Yegorshino deposit make possible gas and coal ejections in other mines of the trust.

Gases in the coal seams of Mine No 2 were tested and results of these tests are shown in the following table. The same composition has been determined in other mines of Yegorshinugol' Trust, Mine No 1 and Mine imeni Kirov. In the adsorbed gas from Mine No 1, carbon monoxide, up to 0.044 percent, and heavy hydrocarbons, 0.14 percent in volume, are present. In the Mine imeni Kirov the content of heavy hydrocarbons reaches 0.20 percent.

Percentage Composition of Gas

Gas Vol per 100 Gm Coal (cu cm)	CH_4	N_2	O_2	CO_2	Heavy Hydrocarbons
320	77.2	19.6	None	3.20	None
420	93.3	5.2	0.4	1.10	None
120	5.7	90.0	3.4	0.75	0.14
340	81.6	12.8	0.7	4.85	Not determined
680	82.5	15.8	0.8	0.90	Not determined
74	23.2	74.2	1.0	1.50	Not determined
Air from dead-end workings	99.5	None	None	0.50	
	99.7	None	None	0.30	

Even these few tests of gases in the Ural coal deposits indicate that the methane content will increase greatly as the mines are deepened. Because of the complex geological structure, the methane content will apparently be very different both when the depth of the workings is increased, and also along the strike of the coal seams even for the same level. The composition of gases in the coal deposits on the eastern slope of the Urals includes heavy hydrocarbons even at a relatively slight depth. These hydrocarbons, as is well known, have a greater tendency to explode than methane.

Karaganda Basin

A detailed study of gases in the Karaganda coal deposits shows that the principal gases encountered are nitrogen, mostly nitrogen-methane (merging into methane), and methane.

An exceedingly interesting phenomenon is that in the Karaganda Basin there are practically no carbon dioxide-nitrogen gases characteristic of the uppermost (from the surface) zone established for the Donbass. Up to 7 percent ethane was found in testing the gas composition of the "Dvoynoy" seam (a_5) in the Ashlyarikskiy series. This is apparently explained by other conditions of coal formation in this series.

The methane content (volume of the liberated gas in cubic meters per ton of output) increases gradually to a depth of 200 meters, and intensity of the methane content increases sharply deeper than this. Thus, at a depth up to 50 meters, no methane is liberated; at a depth from 50 to 100 meters, 0.30 cubic meter; at a depth from 100 to 150 meters, 1.15 cubic meters; at a depth of from 150 to 200 meters, 2.44 cubic meters; and at depths of more than 200 meters, 14.60 cubic meters per ton are liberated.

The reason for this sharp increase in methane liberation at relatively shallow depths is explained by the fact that the Karaganda Basin is not deeply eroded, and erosion determines the depth of demethanization to a considerable degree.

The presence of chloride waters, discovered by mining operations and bore hole drilling even relatively near the surface, also indicates a very shallow extension of active water exchange and, consequently, of the zone of demethanization in the Karaganda industrial section. This is explained basically by the entire geological history of the formation of the basin, and especially by the fact that the coal seams of the Karaganda series, after their formation, were covered by thick strata (more than 500 meters) of sandy, clayey rock of the Alabasskiy, Dolinskiy and Tentekskiy series of the Upper Carboniferous period. This geological history points out the favorable conditions which were present in the basin for the preservation of large quantities of gas in the coal seams. The overlying rock strata obstructed the movement of gases to the surface. This refers especially to Cretaceous and Tertiary clayey rocks which cover the coal seams almost everywhere.

The rate at which methane is liberated and the gas content of coal seams increase with depth but also vary along the strike of the seams. In the Karaganda Basin (Promyshlennyy Rayon), liberation of gas in all the seams increases from east to west up to the central part, where the most gas is encountered, and further west the gas liberation decreases. Methane liberation in the seams increases with the degree of carbonification, as illustrated by the following table:

Liberation of Methane from Coal Seams at a Level of 100-150 Meters

Seam	Geological Index	Methane Liberation Rate (cu m per ton -- daily output)
	Karaganda Series	
"Novyy"	K_{18}	0.0
"Chetyrekhfutovyy" ("Four-Foot")	K_{14}	0.0
"Shestifutovyy" ("Six-Foot")	K_{13}	0.0
"Verkhnyaya Marianna"	K_{12}	1.12

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Seam	Geological Index	Methane Liberation Rate (cu m per ton -- daily output)
	Karaganda Series	
"Feliks"	K_{10}	2.34
"Zamechatel'nyy"	K_7	3.19
"Vyshesrednly"	K_4	3.50
	Ashlyarikskiy Series	
"Dvoynoy"	A_5	9.15

Donets Basin

The gases in the Donbass are basically carbon dioxide, nitrogen, and methane-type gases with a gradual transition to carbon dioxide-nitrogen and nitrogen-methane, and a further transition to methane-type gases. Tests also have shown up to 15 percent hydrogen, belonging mainly to the clayey shales which enclose the coal seams.

In 1948, in the western outskirts of the Donbass at the periclinal dipping of the main anticline, west of the Shcherbinovskiy Mine (rudnik), deep bore holes No 1127 and 1128 of the Artemuglerazvedka (Artem Coal-Prospecting) Trust encountered gas at 500 meters or more from the surface. This gas was liberated along with underground water which gushed out of the holes. The water was a chloride water with mineralization up to 18 grams per liter.

By chemical composition the freely liberated gas is basically a methane gas (N_2, 76.0-78.9 percent; CH_4, 19.7-22.6 percent), with a small content of heavy hydrocarbons; ethane, propane, butane, and pentane.

Tests in the Donbass have established the depth of the zone of demethanization. This depth is, to a considerable degree, determined by the depth of erosion and extends 250-300 meters into the ground. Below the zone of demethanization, the methane content of the coal seams and of the rock surrounding them are determined by tectonic conditions. The following sections of the Tsentral'nyy Rayon of the Donbass (from west to east) contain seams with the highest methane content: (1) zone of the Artemov fold, located on the east side of the coal field, with the maximum amount of gas (up to 80 cubic meters of gas per ton of output); the "Chegarka" seam, on the eastern side, at the 425-meter level (with frequent gas and coal ejections); (2) zone of the "Komsomol'skaya" overthrust fold on the eastern side of the coal field; (3) zone with the highest methane content, a part of the Gorlovka thrust fault, which runs along the eastern side of the field. In this zone the methane content at the 358-meter level exceeds 35 cubic meters per ton of output, at the 640-meter level averages more than 50 cubic meters, and in some seams, the methane content is 180 cubic meters per ton (the "Zolotarka" seam, at a 555-to 640-meter level).

Four types of ground water have been established in the Donbass:

1. Hydrocarbonate-sulfate-calcium-sodium waters (frequently hydrocarbonate-calcium) extending on the average to a depth of 100-200 meters (variations in different regions), belonging to the zone of carbon dioxide-nitrogen gases.

2. Sulfate-sodium waters which extend to depths of 250-300 meters and circulate in the zone of nitrogen-carbon dioxide gases.

3. Hydrocarbonate-sodium waters which are formed through metamorphosis of sulfate-sodium waters in so far as they have penetrated to the depth of the coal-bearing strata and passed into the methane zone. In the Donbass they

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extend to depths of 650-750 meters and belong to the zone of nitrogen-methane and purely methane gases.

4. Waters at relatively deep level (over 700 meters), hydrocarbonate-chloride-sodium waters belonging to the zone of methane gases.

All these underground water types are found in the Tsentral'nyy Rayon along the southern side of the "Glavnyy" (Main) anticline. On the northern side, mixed waters and waters of the oxidation zone, i.e., sulfate-sodium, are found at the bottom of the mines. Waters of the methane zone (hydrocarbonate sodium and hydrocarbonate-chloride-sodium) occur only in the Mine imeni Kalinin at a depth of 410 meters.

The small methane content of many mines along the northern side of the "Glavnyy" anticline is explained by the deeper extension of the demethanization zone. This is caused by the development of eroded cracks which permit the penetration of water. The chemism of the waters along the northern side confirms this conclusion. Here, one can expect a gradual increase in the methane content of the workings, a gradual reduction of eroded cracks and, consequently, a decrease in the inflow into the workings of water circulating in the coal-bearing stratum.

Observations have shown that the rate at which methane is liberated varies in the different coal seams. For example, in the "Tolstyy" seam 20 percent of the methane (without vacuum) was liberated in 3 days while in the "Umanskiy" seam only 6-8 percent was liberated. In 8 days, 40.2 percent of the methane was liberated in the Khrustal'skiy seam but only 15 percent in the "Sadovyy" seam.

In spite of the fact that the absolute methane content in individual cases reached 388 cubic centimeters per 100 grams of coal, e.g., Mine No 32-bis, "Fominskiy" seam, K_8, which is considerably more than in the "Sadovyy' and "Khrustal'skiy" anthracite coal seams, e.g., 170 cubic centimeters - Mine No 16 imeni "Kaganovich of the "Donbassantratsit" Trust, the methane content of Mine No 32-bis 0.9 cubic meters per ton of coal production while in Mine No 16 imeni Kaganovich it is 13.8 cubic meters per ton.

The rate at which methane is liberated has a great practical importance in regard to controlling gas liberation in the mines. In the Donbass it has been established that seams with a high absolute methane content have a high gas output. However, coal with a high methane content may have a small gas output.

In the Donbass, methane is distributed unevenly in the coal strata. Most of the methane is found in the Bokovo-Khrustal'skiy and Chistyakovo anthracite regions. Here the methane content reaches 70-80 cubic meters per ton of output. In Tsentral'nyy Rayon where coal seams of the PZh type are mined, the methane content averages 20 cubic meters per ton. In the Krasnoarmeyskiy and Lisichanskiy rayons, where gas and long-flame coal is mined, the methane content is 5-10 cubic meters per ton.

In conducting operations in the basin, the following factors, which determine the distribution of gases in the basin, must be made clear.

1. Geological conditions of coal formation which determine the composition of gases formed, particularly methane.

2. Dependence of methane content on the degree of metamorphism.

3. Porosity of the coal and rocks as one of the factors which determines their capacity to hold gas.

4. Depth of erosion, which determines the zone of demethanization of the coal-bearing strata.

5. Lithologic composition of the rocks and its importance for the gas content of the coal seams.

6. Effect of tectonics on the distribution of gas in the coal-bearing strata.

7. Influence of underground water on gas content.

8. Interrelation of chemical types of waters and gases in the coal-bearing strata in order to determine the gas hydrogeological chemical zonation to depths up to 1500 meters.

9. Dependence of the rate of gas discharge on the metamorphism of coals and their petrographical composition (by core samples).

10. Determination of the character of the gas content of coal seams in various geotectonic stages of the coal deposit formation.

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